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PENSOFT

New overwintering location of Burrowing Owl, *Athene cunicularia hypugaea* (Molina, 1782) (Strigidae) in Tennessee, USA, with diet assessed through pellets

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Abstract. Reporting new occurrence records of organisms is key to overcome the Wallacean shortfall. Here, we report the first sighting of a Burrowing Owl, *Athene cunicularia* (Molina, 1782), overwintering on a peninsula in the Tennessee River in Tennessee, USA, during boreal winters 2020–2022. Pellets from this bird showed combination of six species. This is the first record for the species in the Interior Plateau of the USA. Conditions supporting this bird and evidence of it overwintering bear to explore the environmental conditions that support this species in novel areas.

Keywords. Bird, insect, omnivore, North America, small mammal prey

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Introduction

Knowledge on the historical and current distribution of living organisms is vital in conservation biogeography and to overcome the Wallacean Shortfall (Riddle et al. 2011). Unfortunately, our understanding on the geographic distribution of birds of prey is deficient in many areas (McClure et al. 2018). Due to the crepuscular and nocturnal habits of many Strigiformes, this group or raptors and their autecology are not well addressed. Given some members of the Strigiformes are experiencing population declines, information on space use by these birds, including during the non-breeding season, is needed to further understand these birds as well as the other species with ecology influenced by them (e.g. Kajtoch et al. 2016). Such information should include details on extralimital records of these birds, particularly within novel environments such as landscapes that are modified by humans (Gomes et al. 2009; Morozov 2023).

Burrowing Owls, *Athene cunicularia* (Molina, 1782), as a species occur in North and South America and the Caribbean (Poulin et al. 2021). Twenty-five subspecies of Burrowing Owl are identified across their range in North and South America (Korfanta et al. 2005; Macías-Duarte et al. 2019; Poulin et al. 2020), and these are represented in migratory and non-migratory populations. Within North America, the population of Burrowing Owl that inhabits Florida, *A. c.* floridana (Ridgway, 1874), is non-migratory. The other subspecies represented in North America, *A. c. hypugaea* (Bonaparte, 1825), has a range that extends from southwestern Canada and western United States to central Mexico. Most members of this subspecies migrate south during the boreal winter, those from northern North America to the southern United States and Mexico, with some moving as far south as El Salvador (Poulin et al. 2020). While most birds migrate along longitudinal routes, some northern birds overwinter in Louisiana and Florida each year, areas east of known migratory populations. Distinction between the populations that are resident in Florida and those that inhabit western North America are supported genetically (Korfanta et

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al. 2005). Generally, however, the migratory behavior of these birds needs further study (Sheffield 1997).

Burrowing Owls exhibit some tolerance to human development and can use a variety of burrow types, including artificial structures (Poulin et al. 2005; Berardelli et al. 2010). Despite their general tolerance to development and adaptability to different burrow types, this species is declining across its range. Some populations, however, exhibit preference for urban areas relative to more rural conditions (Skeel et al. 2001; Conway et al. 2006; Macías-Duarte and Conway 2021). This preference has been posited that urban areas may provide refugia for these owls from the predation pressure they experience in more naturalized systems (Rebolo-Ifrán et al. 2017).

Owls often swallow their prey whole, but unlike many other birds of prey they do not have the capacity to digest harder portions of their prey, items which can injure their digestive systems if not separated out (Taberlet and Fumagalli 1996). Subsequently, owls have a two-part anterior portion of their digestive system comprised of a glandular stomach (proventriculus) and a gizzard (Smith and Richmond 1972). The proventriculus provides separation of harder materials from ingested food, while the gizzard works to grind the remaining material into more digestible components, increasing the surface area over which acids and digestive enzymes can act (Klaphake and Clancy 2005).

Owls regurgitate the material separated by the glandular stomach portions of their food which can include bones, fur, and feathers of their prey. Collection and dissection of these pellets can offer insight into the diet of these birds, albeit limited to the harder materials that cannot be broken down by the bird's gizzard. While novel analytical techniques have been paired with direct identification of prey remains from owl pellets (Gehler et al. 2012; Kryshak et al. 2022), dissection of these pellets remains one of the most typical means to assess the diet of owls (Cheli et al. 2019; Montalvo et al. 2020).

Despite some *A. c. hypugaea* migrating south in fall along a southeasterly route, no Burrowing Owls have been detected in Tennessee until 2021. Here we describe the presence of a Burrowing Owl occurring during the winters of 2020–2022 in Tennessee. We describe the diet of this bird, as assessed from remains collected in March 2022 in pellets from a site regularly occupied by this individual. Throughout the period of observation, we observed a single owl at the occupied burrow and surrounding area. Although we cannot be certain that this is the same bird that returned to this site each of these three years the likelihood of a different bird occurring at this location is unlikely.

Methods

A Burrowing Owl was first detected at the Tennessee Valley Authority Johnsonville Fossil Fuel Plant in New Johnsonville, Tennessee (36°01′34″N, 087°59′33″W) in March 2021 (EBH pers. obs.). This bird was observed occupying a burrow on a 3 km^2 peninusla within the Tennessee River.

On 4 April 2022 four pellets were collected from the burrow that had been occupied by this Burrowing Owl. The owl had been observed at this burrow on 1 April 2022, but the burrowing was found unoccupied on 4 April 2022. Pellets were located within the first 0.25 m of this burrow and considered fresh based on their general dark appearance as well as absence of notable degradation and decay. Pellets were dissected to identify prey items consumed by this owl. Identification of prey items was limited to larger materials that could be discerned using a dissecting microscope (Fisher Scientific Stereomaster II, Fisher Scientific, Pittsburgh, PA). Mammalian remains—larger components of skulls including lower mandibles—were identified using keys by Schwartz and Schwartz (2001).

Results

***Athene cunicularia hypugaea*, Bonaparte, 1825**

Figure 1

New record. USA – **Tennessee** • New Johnsonville; 36°01′34″N, 087°59′33″W; 108 m elev.; 22.III.2021; S. Rush, A. Naveda-Rodríguez, E. Hamrick obs.; 1 likely ♂.

Identification. Using photographs collected of this Burrowing Owl, this bird was identified as belonging to the subspecies *A. c. hypugaea* (Fig. 1). Identification to this subspecies was made by the appearance of this bird with a medium-brown dorsum, a buffy ventrum, and buffy spots on the dorsal feathers (Poulin et al. 2020; Fig. 1). We sexed this bird as male through observations and photographs; its lighter body plumage is an attribute of males during the time of year when they are typically associated lighter underbody plumage along the chest, a product of wear (Pyle 1997). However, as this sexing criteria may be limited to only birds known to be breeding, this assessment of this bird's sex should be considered with caution.

This record of Burrowing Owl is the first documentation of this species in the state of Tennessee and the Level IV Western Highland Rim Ecoregion, and it is the second known record in the Level III Interior Plateau Ecoregions of North America (Commission for Environmental Cooperation 1997). Two prior observations near the current record exist for this species, but both records are >100 km west of this bird's location: one record in Kentucky of a bird detected in 2020, 108 km from this bird's location in Tennessee (Heath 2020), and the other record in Missouri in 1993, 197 km from this location (Wilson 1993; Fig. 2).

The site where this Burrowing Owl has been observed in Tennessee is on a 2 km long peninsula, with area of 0.75 km^2, within the Tennessee River. Approximately 25% of this peninsula is covered with materials from energy production using fossil fuels and crushed rock used in

Figure 1. Burrowing Owl, *Athene cunicularia*, observed overwintering in New Johnsonville, Tennessee, USA. Photograph taken on 19 November 2022 by T. Ross.

construction activities, both occurring nearby. Wetlands cover 18% of this peninsula, with grassland and hardwoods comprising other landcovers. The burrow where this owl has been observed occupying is ~1 m from the edge of a small wetland with an area of ~150 m^2.

Each winter (2020–2022) the Burrowing Owl observed at this site in Tennessee has been observed using the same burrow, a burrow likely created by a Muskrat, *Ondatra zibethicus* (Linnaeus, 1766), or Nine-banded Armadillo *Dasypus novemcinctus*, Linnaeus, 1758. Fifteen items could be identified within the four pellets collected from within this burrow. These prey items included insect, mammalian, and plant remains, as well as the cheliped of a crayfish (Table 1). Though numerous other bones were within these pellets they were not visually identifiable to species.

Discussion

Burrowing Owls occur throughout the Western Hemisphere but in North America do not inhabit the eastern portion of the continent outside of Florida (Fig. 2). We have identified a Burrowing Owl that frequented New Johnsonville, Tennessee in the winters of 2020–2022. We do not know specifically where this bird migrates to during the breeding season, nor can we explicitly confirm that it is the same individual. Yet, we have identified the sex and subspecies of this Burrowing Owl as the same for each winter this bird has inhabited this site. Burrowing Owls are known to exhibit site fidelity to breeding and overwinter sites (Poulin et al. 2020). The Burrowing Owl observed in New Johnsonville, Tennessee has used the same burrow for three consecutive

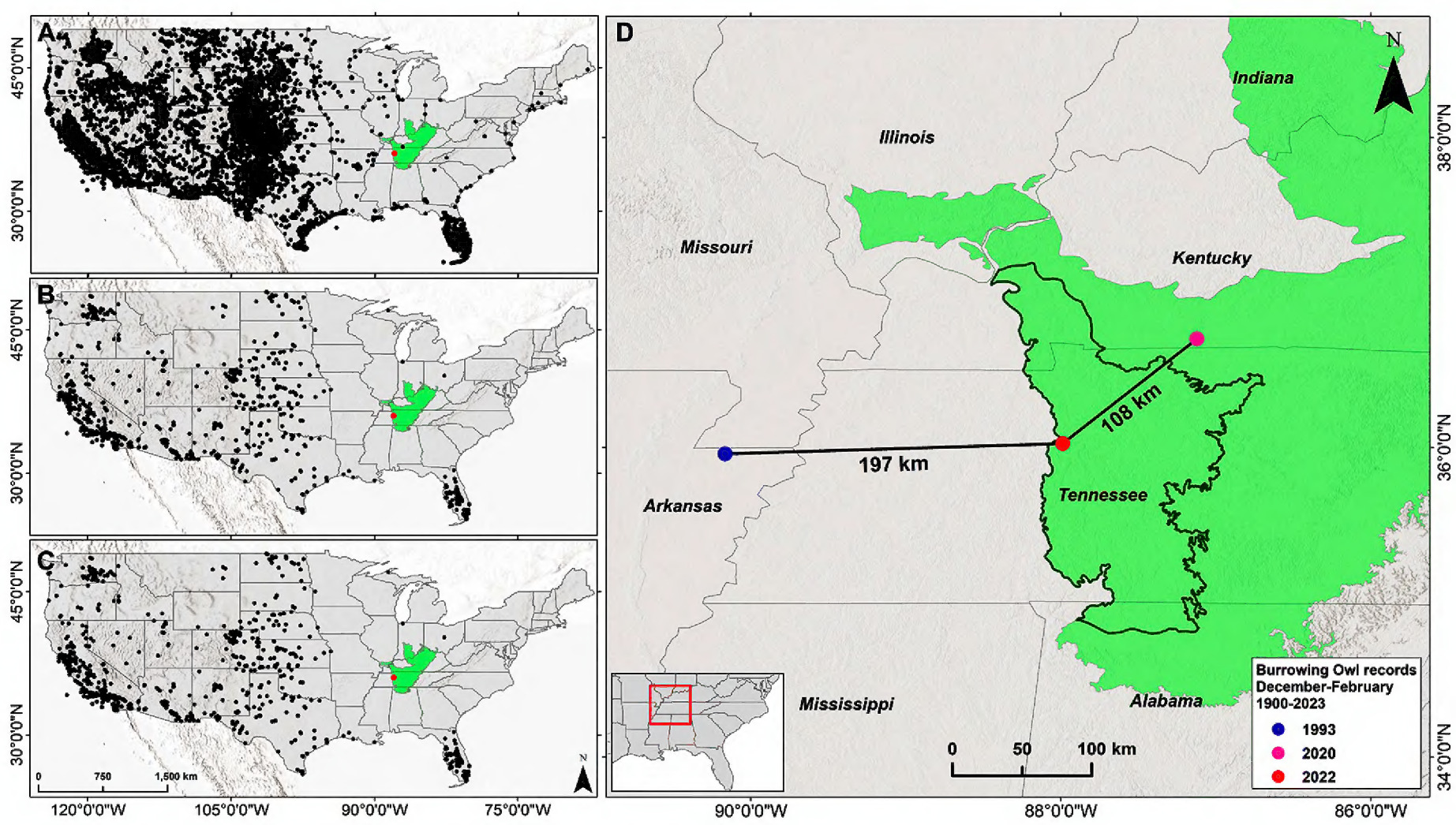

Figure 2. Distribution of locations of Burrowing Owl *Athene cunicularia*, records for North America. **A.** Point locations are derived from eBird (ebird.org/home) observations. **B.** Point locations reflect records cataloged in iNaturalist (www.inaturalist.org). **C.** Locational information derived from museum specimens. Red dot is the new record for this species from New Johnsonville, Tennessee, USA where cast pellets were collected. **D.** Location in New Johnsonville, Tennessee, USA relative to the most geographically proximate locations where species has been detected. Green shadow illustrates the Level III Interior Plateau Ecoregion while the green line demarcates the Level IV Western Highland Rim Ecoregion.

Table 1. Materials found and identified from four pellets deposited by Burrowing Owl, *Athene cunicularia*, in New Johnsonville, Tennessee; *n* represents the number of each item identified within the pellets collected.

Item	*n*	Tissue	Family	Species
Crayfish	1	Cheliped	Cambaridae	—
Scarab beetle	1	—	Scarabaeidae	—
Carabid beetle	2	—	Carabidae	—
Deer mouse	2	Skull	Cricetidae	*Peromyscus maniculatus*
	6	Lower mandible		
Least Shrew	2	Skull	Soricidae	*Cryptotis parva*
Carolina Horsenettle	1	Fruit	Solanaceae	*Solanum carolinense*

years. Longevity records for Burrowing Owls indicate that they can survive for at least nine years (Clapp et al. 1983). Unfortunately, it was not possible to age this Burrowing Owl when it was first observed at this site. Although site fidelity to breeding sites has been documented in Burrowing Owls, the level of fidelity this species exhibits to overwintering locations is less well known (Woodin et al. 2007). Use of this site and the same burrow in Tennessee for three consecutive years demonstrates that this individual does exhibit site fidelity to this overwintering site.

Burrowing Owls are known to be opportunistic, generalist predators foraging on materials as available by season (Silva et al. 1995). Food items can include vertebrate and invertebrates, with invertebrates most numerous in abundance but vertebrate prey comprising the greatest biomass (Poulin et al. 2020). Our findings of prey remains in the pellets of the Burrowing Owl collected in New Johnsonville, Tennessee—albeit only four pellets were examined—support this species generalist diet, including invertebrate and vertebrate items. Carabid, scarab beetles, and crayfish remains have been reported in this species' diet in other portions of its range (Tyler 1983; Thompson and Anderson 1988; Sarno et al. 2012; Poulin et al. 2020).

The mammalian remains found in these pellets are indicative of the grasslands found within the peninsula where this Burrowing Owl has overwintered. Small mammals such as shrews and mice are abundant in these grassland systems (Kitchings and Levy 1981). Although we limited our assessment to numerical inference of prey remains, and only to those large enough to be easily discernable using magnification, we believe that these items are generally representative of what is available to this bird within short distances of its burrow. While estimates of home-range size are available for birds during their breeding season from Saskatchewan, Canada (Haug and Oliphant 1990), we know of no metrics of space use for these birds during the winter, especially in areas outside of their typical geographic range.

Burrowing Owls, in general, have a general diet consisting of animals, invertebrates and some vegetable matter (Poulin et al. 2020). Food items available in this novel environment have sustained this owl for three winters. Why these birds have not expanded their range to additional areas of North America, given the likelihood that they could find suitable diet items, is of interest as it may provide insights into where they can occur, or are likely to be extirpated from within their current range (Macías-Duarte and Conway 2015). Soil and climate have been found to be strong predictors of Burrowing Owl space use elsewhere in North America (Stevens et al. 2011). The burrow for this individual is in a drainage ditch next to an industrial site where soil is largely comprised of a combination of tailings from a former coal burning power plant and native soils. The occurrence of the Burrowing Owl overwintering at this location for three consecutive years suggests that the conditions at this site provide a soil structure more suitable than others than those often available in this geographic area. Birds overwintering in Texas are known to show preference for soil structure on barrier islands and agricultural fields (Poulin et al. 2020), conditions in ways comparable to this site in Tennessee.

Although Burrowing Owl populations are declining across much of their range, knowledge of distribution of these organisms, including extralimital records, is vital to the conservation of this species. Information gained from these records of the persistence of individuals within novel environments can provide insight into the broader array of conditions that can support these animals.

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Author Contributions

Conceptualization: SAR, ANR. Data curation: SAR, ANR. Formal analysis: SAR, ANR. Funding acquisition: SAR. Investigation: SAR, ANR, EBH. Visualization: SAR, ANR. Project administration: SAR, EBH. Writing – original draft: SAR, ANR. Writing – review and editing: SAR, ANR, EBH.

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